ANTIMICROBIAL SUSCEPTIBILITY IN SURGICAL SITE INFECTIONS AFTER ABDOMINAL SURGERY AT KENYATTA NATIONAL HOSPITAL KENYA

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DISSERTATION SUBMITTED IN PART FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF MEDICINE DEGREE (MMed) IN GENERAL SURGERY AT THE UNIVERSITY OF NAIROBI

Declaration

I declare that this dissertation is the result of my original work and that it has not been submitted either wholly or in part in any other institution for an academic award.

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Date: _____

Supervisor's Approval

This is to certify that this dissertation has been submitted for examination in partial fulfillment for the award of the degree of Masters of Medicine (General Surgery) of the University of Nairobi with our approval as internal supervisors.

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Abbreviations/ Acronyms

KNH-Kenyatta National Hospital

UON-University of Nairobi

SPSS-Statistical Package for Social Sciences

LOS-Length of Hospital Stay

CI-Confidence Interval

ERC- Ethics and Research committee

SSI-Surgical site infection

MCS-Microscopy, culture and sensitivity

HAIs-Hospital Acquired Infections

MRSA-Methicillin Resistant Staphylococcus Aureus

ABSTRACT

Background

Six (6) month cross-sectional study done at KNH surgical wards on SSI related factors, antimicrobial profile and antibiotic susceptibility testing. The mostly cultured organism is E. coli at 38.9% this is followed at a distant by klebsiella pneumonia and Acinetobacter baumabii at 9.3% each. Mono-microbial SSI accounted for 93.5 % while poly-microbial represented 6.5% of SSIs.

E. coli is 100% resistance to penicillin and also high resistance (over 80%) to cephalosporin. There is also more than 50% resistance to cephalosporin. It is highly sensitive to meropenem and the aminoglycosides (over 80%).

Determining the causative organisms in surgical site infections and the antibiotic sensitivity and resistance patterns helps to guide clinicians on the choice of antibiotics to be initiated. The knowledge of the prevalent organisms and the drug susceptibility helps in cases where empirical treatment has to be initiated before culture is done.

Objective

To determine the antimicrobial susceptibility pattern of bacterial isolates from surgical site infections after laparotomy in KNH.

Methodology

This was a prospective analytical study conducted at the general surgical wards in Kenyatta National Hospital on post laparotomy patients with surgical site infections.

Ethical approval from the KNH/UON Ethics and Research Review Committee was sought. Assent and Informed Consent was sought from eligible patients then a data sheet filled from the patients file while assent was got from the parents/guardians of the minors.

Pus swab and pus was collected and taken to the microbiology lab in Kenyatta National Hospital followed by data entry after receiving the results.

The data was analyzed using SPSS version 22 and presented in tables, pie charts and association analysed using chi-square.

Significance of study

With development of antibiotic resistance and emergence of multi drug resistance strains of microbes, focused management of surgical site infections is highly advocated. This helps in shorter hospital stay, less cost burden and also helps avoid emergence of drug resistant strains by avoiding misuse of antibiotics.

1. Introduction

Wound infections have been a challenge for a long period of time. Malgaine, a French scientist in 1941 gave the first statistics on post-operative mortality. The mortality from amputations then was 60% mainly from hospital acquired infections. [(1)]

Wound infection is largely a clinical diagnosis.

Surgical wounds are classified as clean, clean contaminated, contaminated and dirty.

Surgical site infection is an infection that occurs in a post-operative wound or in a post-operative patients in organs near the point of operation. It requires evidence of clinical signs and symptoms.

Risk factors for development of surgical site infection:-

Patient factors such as age, infections, obesity, smoking and malnutrition, prolonged hospital stay before operation, pre-operative factors, prophylactic antibiotics, operating room characteristics and post-operative issues.

In an essay, the author Luis R Ferdinand noted that during the Pasteur era, ninety percent of surgeries ended in a mortality due to infections. [(2)] It is this mortality that made Pasteur to come up with the antiseptic idea that was later revolutionalised to aseptic technique in surgery.

During the 1870s, work by Erichsen showed that approximately 36% of amputation patients died even after successfully undergoing surgical operations. Lister and Koch were able to demonstrate the presence of bacteria in wounds in 1878. Different bacterial species were later isolated in 1881 by Koch. [(3)]

Histologically a number of challenges affected wound care in the 20th century including wound contaminations in the WW1, **(4)** the introduction of antibiotics in infection control and later bacterial resistance to antibiotics **(5)** among others.

1.1 Literature Review

Superficial Incisional Surgical Site Infection [6]– Involves the skin or subcutaneous tissue and should occur within 30 days of after the operation. In addition should meet one of the following criteria:-

Pus coming from the incision with or without microbiological confirmation, microbes cultured from the incision, at least one sign of infection: edema, warm the, localized pain, erythema *and* the incision having been opened by the surgeon and finally the surgeon makes the diagnosis.

Deep Incisional Surgical Site Infection[6] – Affects deep soft tissues like muscle or fascia within incision and should occur within 30 days after the operation if no implant or within 1 year for operation with an implant in place and is related to the operative procedure. In addition should meet one of the following criteria:-

Pus from the incision, wound dehiscence or deliberate opening due to at least one of the signs of infection, collection of pus or evidence of infection within the deep tissues during reoperation, radiological exam, examination or pathologic exam and the diagnosis is made by a surgeon.

Organ/Space Surgical Site Infection[6] – Does not involve the incision, when no implant occurs within 30 days after operation or within 1 year if there is implant and it's directly associated with the procedure.

Pus coming through a drain left intra-operatively, microbes cultured from tissue or fluid from the space/organ, abscess or other evidence of infection involving the deep incision is found during examination of incision, reoperation, or pathologic or radiologic exam and diagnosis is made by the surgeon.

A number of studies have been done locally at KNH on prevalence of SSIs and the microbial isolates. In one of the studies done in the general surgical wards, among patients undergoing abdominal surgery, SSI prevalence was found to be 22.4% [7] while in another, after emergency abdominal surgery, the prevalence was 30.8%[8] (these are comparable to studies done regionally and internationally that found a prevalence of between 9.4% - 30.8% [9, 10, 11, 12, 13]); organ space was the most common type. Mono microbial infections were more prevalent than poly microbial ones; 84.4% and 15.2% respectively. E. coli was the most prevalent pathogen at 48.6%. [(7, 8)]

The study by Mwendwa K M done at KNH found that patients treated with antibiotics for more than 5 days had an SSI prevalence of 29.2% compared to those on shorter time of antibiotic therapy at 7.5%. This is supported by a study done by Stephen Harbarth et al that showed prolonged antibiotic prophylaxis had no relation with reduced risk of SSIs and was associated with increase in risk of antibiotic resistance. [(5)]

Elamenya Linet [(14)] in her study in 2014 in the paediatric surgical unit in KNH found that the most prevalent pathogens in wound infections were staphylococcus aureus, pseudomonas aeruginosa, proteus spp, coagulase negative staphylococcus, beta hemolytic streptococcus and klebsiella in decreasing order. Mixed infections accounted for 8.67% of all SSIs. Pathogen sensitivity to drugs was assessed; the only organism sensitive to all antibiotics available was klebsiella. Staphylococcus aureus was highly sensitive to ceftriaxone but resistance to

ceftazidime; 50.6% of the staphylococcus were Methicillin-resistant Staphylococcus aureus (MRSA). Escherichia coli was sensitive to ciprofloxacin but resistant to imipenem, ceftriaxone, ceftazidime, amoxicillin-clavulanic and cefuroxime. Pseudomonas aeruginosa was highly sensitive to ciprofloxacin and imipenem but less sensitive to ceftazidime and resistance to ceftriaxone.

Eriksen et al [(15)] in his study at Kilimanjaro Christian Hospital showed that 88% of those who developed surgical site infections were on antibiotics. The commonest pathogen isolated was staphylococcus aureus followed by Escherichia coli and klebsiella respectively. They found that the incidence of surgical site infections and antibiotic resistance prevalence wash high.

In a study in India by Mundhada A S et al, [(16)] staphylococcus aureus isolate was most dominant followed by gram-negative isolates. Other studies also showed staphylococcal aureus as the most prevalent cause of surgical site infections. [(17) (18)] E. coli was the most prevalent among the gram negatives. On susceptibility testing, staphylococcal isolates had varying degree of sensitivity to erythromycin, gentamicin and ciprofloxacin. This was comparable to another study by Thu et al. [(2)] All were sensitive to cefoxitin and cefotaxime but all were resistant to penicillin. E. coli had varying levels of sensitivity to the various antibiotics used in the study.

In a study done by Yoshio Takesue et al [(19)] in Japan, the most isolated pathogen was S. aureus at 20.4% followed by E. faecalis at 19.5%. Other isolates were P. aeruginosa at 15.4%, B. fragilis at 15.4% and E. coli at 13.5%. The staphylococcal and aeruginosa pathogens were prevalent in incisional surgical site infections while enterobacteriaceae species was prevalent isolate in organ/space surgical site infections. With respects to gram negative pathogens, over 75% of the isolates were found to have multi drug resistance. This compares to a study done by Ghaleb

Adwan et al [20] in Palestine where E. coli isolates had 94.1% resistance to 3 or more antibiotics while S. aureus had a 77.8% resistance.

Devirik et al [13] in a study about prevention of surgical site infections, the impact of SSIs to healthcare was highlighted. Other studies showed 60% of surgical site infections could be prevented [21, 22] and that 77% of deaths were attributed to surgical site infections in patients who had wound infections.

1.2. Statement of the Problem

Surgical site infections have been and continue to be a challenge to surgeons. Surgical site infections are responsible for increased readmission rates, length of hospital stay, reoperation, patient morbidity and mortality, as well as increased overall health care costs.[11, 23, 24] Patients with surgical site infections have been shown to have an increased risk of dying as opposed to those without.[25] With many options from a variety of antibiotics, increased use of many of them is associated with emergence of resistance to these drugs[17] while in fact in some of the cases the antibiotics may not be necessary hence infection source control is adequate.

1.3. Justification

Antimicrobial resistance remains a major public health issue globally. Resistance is not a new phenomenon but it is steadily increasing in prevalence and impact causing significant morbidity, mortality and economic loss. Antimicrobial stewardship requires appropriate surveillance and analysis of resistance patterns to guide the use of available antibiotics.

The previous studies done at the general surgical wards in Kenyatta National Hospital looked at the prevalence of surgical site infections.[7, 8, 11] A study by Miima looked at the bacterial isolates and classified them according to type of surgical site infections. However a study has not been done by looking at the commonly used antibiotics at the surgical wards and susceptibility of the isolates to these drugs.

Elamenya Linet [(14)] in her study in 2014 in the pediatric surgical unit in KNH did bacterial isolates and microscopy, culture and sensitivity. The only organism sensitive to all antibiotics available was klebsiella. Staphylococcus aureus was highly sensitive to ceftriaxone but resistance to ceftazidime. Methicillin resistant staphylococcus aureus was 50.6% of the staphylococcus aureus species meaning we might be dealing with multidrug resistant strains of micro-organisms in the surgical wards. Escherichia coli was sensitive to ciprofloxacin but resistant to amoxicillin-clavulanic cefuroxime, ceftriaxone, imipenem and ceftazidime. Pseudomonas aeruginosa was highly sensitive to ciprofloxacin and imipenem but less sensitive to ceftazidime and resistance to ceftriaxone.

This shows the importance of determining the etiologic agent and the drug sensitivity in the final selection of the antibiotics. Knowledge of the likely organism and the local antibiotic sensitivity/resistance pattern can very much assist in drug selection.

2.0 Research Objectives

2.1. Broad Objective

The study determined the antimicrobial sensitivity patterns of bacterial isolates from surgical site infections after abdominal surgery in Kenyatta National Hospital general surgical wards.

2.2. Specific Objectives

1. The most prevalent bacterial isolates in SSI wounds in general surgical wards in KNH were determined.
2. The antimicrobial sensitivity in bacterial isolates in SSI wounds in general surgical wards in KNH was determined.

3.0 Study Design and Methodology

3.1. Study design

This was a prospective analytical study that was conducted over a four month period from the month of March 2019 to June 2019, where pus swab and pus specimens from surgical patients with surgical site infection were taken for microscopy, culture and sensitivity.

3.2. Study setting

The study was carried out at the general surgery wards in the Kenyatta National Hospital. Kenyatta National Hospital is a tertiary referral hospital located in Nairobi Kenya; it is the biggest hospital in Eastern and Central Africa with a bed capacity of over 2000. The Hospital serves as the teaching and referral hospital for the University of Nairobi, College of Health Sciences. The unit of general surgery is entrenched in the department of surgery has 3 wards with a total bed capacity of 120.

3.3. Study population

The study population was all post abdominal surgery patients with surgical site infection and had consented to participate in the study.

3.4. Inclusion criteria

- All patients in the hospital above 13 years of age who had surgical site infection and had consented or assented for the study.

3.5. Exclusion criteria

Patients who had been referred post-operatively and had a surgical site infection.

Patients who declined to participate in the study.

Wounds covered with necrotic eschar or slough.

3.6. Sampling technique

A convenient sample of consenting patients was taken until the calculated sample size was achieved.

3.7. Sample size

The sample size calculation was done using the finite population correction formula.

$$n = \frac{Z^{2*}P\,(1-P)/d^2}{1+ (z^2*p\,(1-p)/d^2N)}$$

Confidence interval	95%
P (the sample proportion of SSIs patients with E.coli isolate for 6 month s)	0.224[7]
d = Degree of accuracy expressed as a proportion	0.05
N = Population (estimated patients with SSIs)	107[8, 26]
Z = Standard deviation	1.96
n = Calculated sample size	86

According to study done by Mwendwa [(7)], the proportion of E.coli was used since it's the most frequent isolate in the previous study.

n = 86.

However, only a sample size of 62 was achieved.

3.8. Research instruments

A structured datasheet was used to collect data.

Labelled pus swabs and pus bottles were required for collection of samples and this was accompanied by a laboratory request form. A container for shipment of the samples to KNH microbiology laboratory within 24 hours of collection was used.

Personnel: The principal investigator, one research assistants and one laboratory technician. The research assistant was recruited from among the qualified nurses in KNH.

Training procedure: In order to control for inter-examiner variability the research assistant, who was a qualified nurse, she was trained on how to perform the pus swab collection procedure and on how to extract data from the patients file to the data sheet. The expected responses was explained to them. Successful training was confirmed by occasional supervision of research assistant and filling of the datasheet by the Principal investigator during the pre-testing phase.

The role of the principal investigator was to train and supervise the research assistant, co-ordinate with the laboratory technician and ensure quality and reproducibility is maintained throughout the study.

3.9. Data collection methods

The researcher used a structured datasheet when collecting data from the patients file after the patient signed the consent form. The datasheets were coded according to the file number so as to help in tracking the study participant's file.

3.10. Specimen collection methods

Procedure

A clean work surface was prepared. The procedure was explained to the patient. Patient positioning and hand washing then followed. The wound dressing pack and normal saline for cleaning the wound was set up. The wound was exposed then the researcher changed gloves to sterile type.

The wound was cleaned and rinsed with normal saline until there was a $1cm^2$ area of viable tissue.

The tip of the swab was rotated over the viable tissue for 5 seconds and the swab was immediately placed into the medium and closed.

The pus swab specimen bottles were labeled in sync with the code on the data sheet to avoid mix up of data. The date and time of specimen collection with the initials of whoever took the sample was clearly written on the laboratory request form. The specimens in a plastic biohazard bag then taken to the laboratory immediately.

For specimens from organ/space SSIs, the specimen was done using pus bottles. The point of collection was during re-operation in the operating theatre or at the interventional radiology procedure room. The pus bottles was similarly be collected, labelled and taken to the laboratory immediately.

Specimen analysis and process in the laboratory

The pus samples were examined for its appearance, color, consistency and presence of granules.

Microscopic examination

An evenly spread smear of the specimen was prepared on a clean grease free glass slide. The smear was allowed to air dry, heat fixed and stained by Gram stain method. The smear was then examined for the presence of bacteria and cellular elements using microscope.

Culture

The second swab was inoculated onto plates of 5% Sheep Blood agar (BA) and MacConkey agar (MA) by rolling the swab over the agar and streaking from the primary inoculums, using a sterile bacteriological loop. These plates were incubated at 37°C for 24-48 hours.

Characterization and Identification

All types of colonies on the primary plates were examined macroscopically for haemolysis in BA, changes in physical appearance of differential media, and the colony characteristics were recorded. The colony present on these plates was gram stained, identified by motility testing, biochemical testing and antibiotic susceptibility testing.

Gram's staining

Colonies on MacConkey's Agar and blood agar plates were stained by gram's staining method and the morphology, gram reaction and arrangement of the microorganisms were noted.
In the lab test, the specimen is put in a special media that is favorable for bacterial growth.

Biochemical testing

Catalase and coagulase testing were done for confirmation of Gram positive bacterial isolates. For Gram negative bacterial isolates, different tests were done-Indole, MR, VP, Citrate utilization test, OF and Urease.

Antibiotic susceptibility testing

Antibiotic sensitivity testing was performed using the standard disc diffusion method recommended by the Clinical and Laboratory Standard Institute for the following antibiotics: Amikacin, Amoxycillin-clavulanic acid, Gentamicin, Ampicillin-sulbactam, Piperacillin-sulbactam, Meropenem, Ciprofloxacin, Ceftazidime, Cefotaxime, Ceftriaxone, Cefipime, Cephalexin, Ciprofloxacin, Cotrimoxazole, Azithromycin, Erythromycin, Penicillin, Ampicillin, and Vancomycin.

Validation

Validation of the results may not be possible since I will only use one laboratory. However, Kenyatta National Hospital Laboratory undertakes periodic external quality assurance through the World Health Organization – National Institute for Communicable Diseases, South Africa (WHO/NICD) and United Kingdom National External Quality Assurance Service (NEQAS) hence I have reassurance that the quality of the results meets international standards and are very reliable.

3.11. Data management

Data was entered into a computer database and thereafter analyzed using the IBM Statistical Package '+-Social Sciences (SPSS) version 22'. Regular back-up of the data was done to avoid any loss or tampering.

Measures such as frequency, mode and percentages have been used to describe quantitative data. Descriptive data is presented in form of tables, pie charts and graphs. Association between microbial profile and antimicrobial sensitivity will be analyzed using chi square and results presented in charts and tables.

3.12. Limitations of the study

The study sample size was not achieved due to lack of specimen collection tools which were out of stock and hence only 62 cases were collected. This limited the ability to do analytical measures of association that was also limited by the fact that some patients grew more than one organism and the antibiotics used were different hence the independence of observations would have been violated.

The quality and validation of the MCS samples may not be possible since I will only use one laboratory.

3.13. Ethical consideration

Clearance was sought and obtained from the Ethics and Research Committee Kenyatta National hospital/University of Nairobi. An informed consent and assent was sought from all participants. Written consent was obtained for all patients above the age of 18 years. Since there were patients between the ages of 14 and 18 years in the surgical wards, consent was sought from the parents while the clients assented in writing to take part in the study. The procedures did not impact on increased cost of care to the patient, confidentiality and the procedure of specimen collection did not affect the overall healthcare of the patient or have any negative impact.

4.0 Research Findings

4.1 Introduction

The main objective of the study was to determine the antimicrobial sensitivity patterns of bacterial isolates from surgical site infections after abdominal surgery in Kenyatta National Hospital general surgical wards 5A, 5B and 5D of Kenyatta National Hospital. A total of 62 surgical patients with surgical site infection whose pus swab and pus specimens were taken for microscopy, culture and sensitivity during a four month period from February 2019 to June 2019.

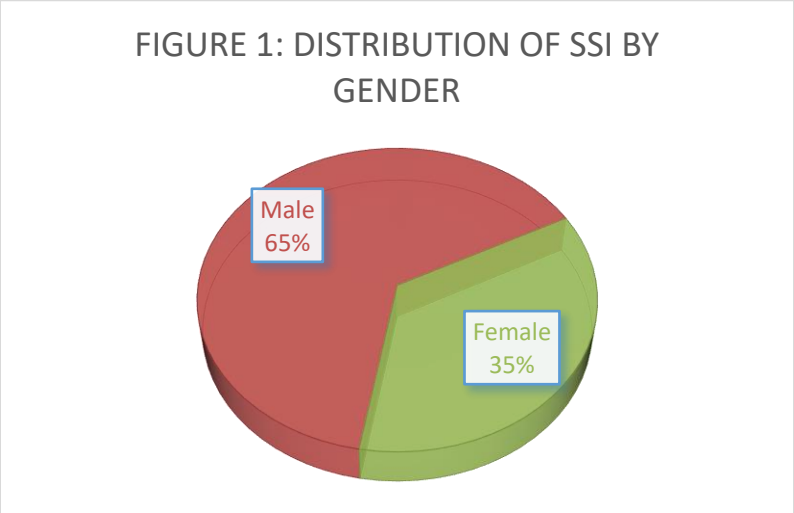
4.2 Patient characteristics

This section describes the patient characteristics.

4.2.1. Distribution of SSI by Gender

Table 1

Gender	Frequency	Percentage
Male	40	64.5%
Female	22	35.5%
Total	62	100%



4.2.2. Distribution of SSI by Age

Table 2

Age	Frequency	Percentage
<18	4	6.5%
18-35	40	64.4%
>3535	18	29.1%

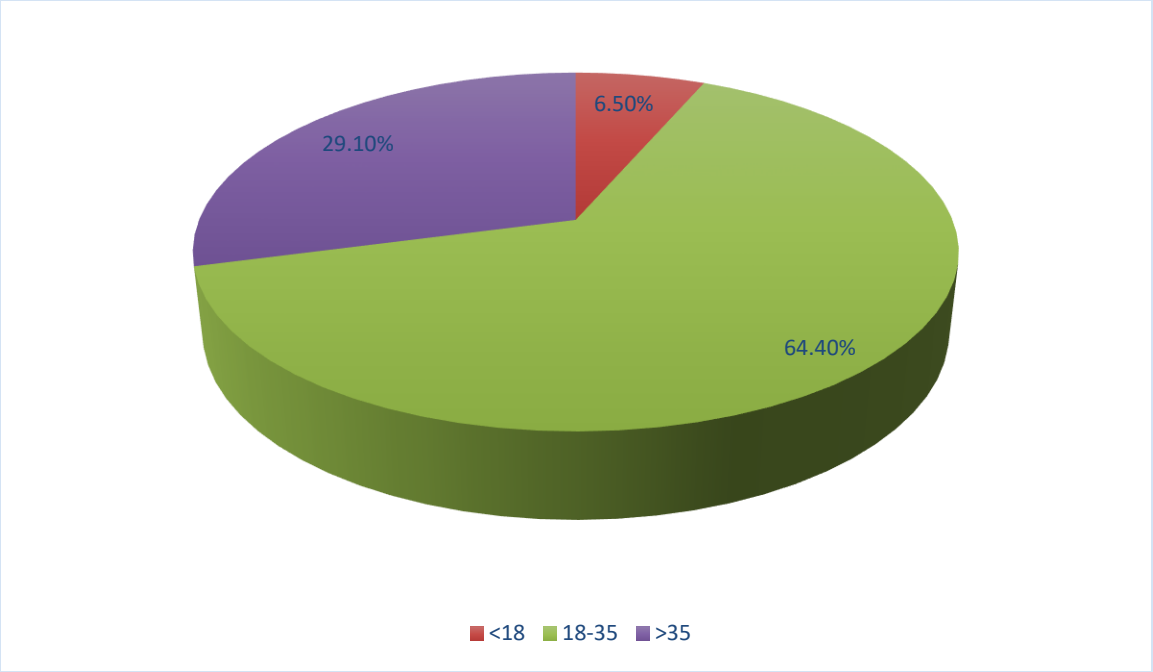


Figure 2: Distribution of SSI by Age

4.2.3. Distribution of SSI by diagnosis

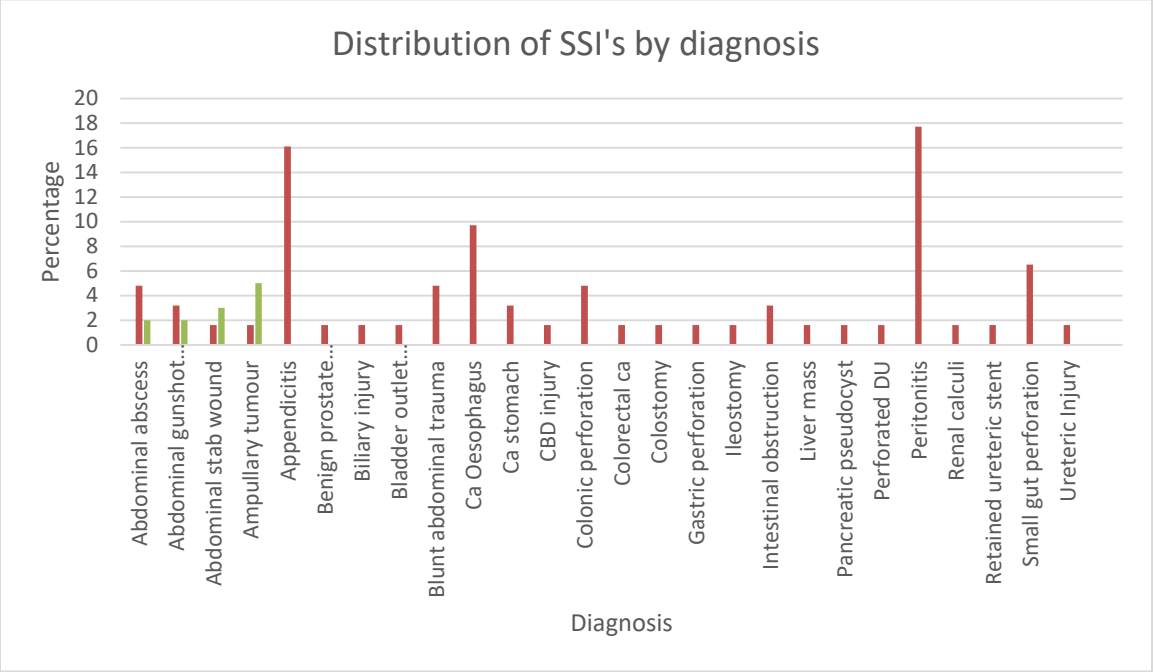
Table 3

The diagnosis of the patients is as shown by the table below.

Diagnosis	Frequency	Percentage
Abdominal abscess	3	4.8
Abdominal gunshot wound	2	3.2
Abdominal stab wound	1	1.6
Ampullary tumour	1	1.6
Appendicitis	10	16.1
Benign prostate enlargement	1	1.6
Biliary injury	1	1.6
Bladder outlet obstruction	1	1.6
Blunt abdominal trauma	3	4.8
Ca Oesophagus	6	9.7
Ca stomach	2	3.2
CBD injury	1	1.6
Colonic perforation	3	4.8
Colorectal ca	1	1.6

Colostomy	1	1.6
Gastric perforation	1	1.6
Ileostomy	1	1.6
Intestinal obstruction	2	3.2
Liver mass	1	1.6
Pancreatic pseudocyst	1	1.6
Perforated DU	1	1.6
Peritonitis	11	17.7
Renal calculi	1	1.6
Retained ureteric stent	1	1.6
Small gut perforation	4	6.5
Ureteric Injury	1	1.6

Figure 3: Distribution of SSI by Age



4.3. Category of Operation

Table 4: Category of Operation

The operation of the patients is as shown by the table below.

Operation	Frequency	Percentage
Appendicectomy	9	15.3
Abdominal pelvic resection	1	1.7
Gastric bypass	1	1.7
Closure	1	1.7
Colostomy	2	3.4
Cystogastrostomy	1	1.7
Distal gastrectomy	1	1.7
Gastrojejunostomy	1	1.7
Gastrostomy	6	10.2
Grahams patch	1	1.7
Hemicolectomy	1	1.7
Hepaticojejunostomy	2	3.4
Laparatomy	19	32.2
Open prostatectomy	1	1.7
Open pyelolithotomy	1	1.7
Open pyeloplasty	1	1.7
Open ureterolithotomy	1	1.7
Resection and anastomosis	2	3.4
Suprapubic catheterization	1	1.7
Fecal diversion (stoma)	3	5.1
Ileostomy	1	1.7
Ureteric implantation	1	1.7
Whipples operation	1	1.7

Category of operation

Operation	Frequency	Percentage
Biliary	4	6.557377049
Appendicectomy	9	14.75409836
Gastric	11	18.03278689
Small bowel	5	8.196721311
Laparatomy	19	31.14754098
Colonic	7	11.47540984
Urology	6	9.836065574
Total	61	100

4.4. Type of Operation

Table 5: Type of Operation

The type of operation of the patients is as shown by the table below.

Operation	Frequency	Percentage
Elective	14	22.6
Emergency	48	77.4
Total	62	100%

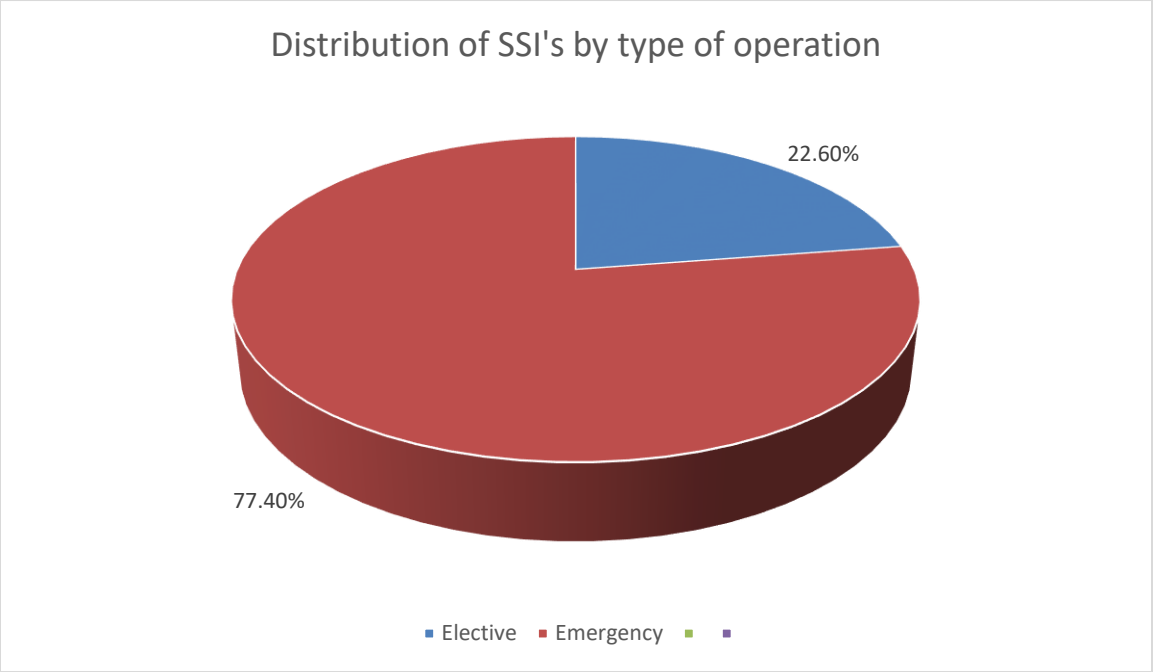


Figure 4: Distribution of SSI by type of operation

From the study, most of the operations were done on emergency setting (77.4%). Only 22.6% were elective.

4.5. Duration of Operation

Table 6: Duration of Operation

The duration of operation of the patients in minutes is as shown by the table below.

Duration in minutes	Frequency	Percentage
0-90	14	22.6
91-120	18	29.0
121-240	24	38.7
>240	6	9.7

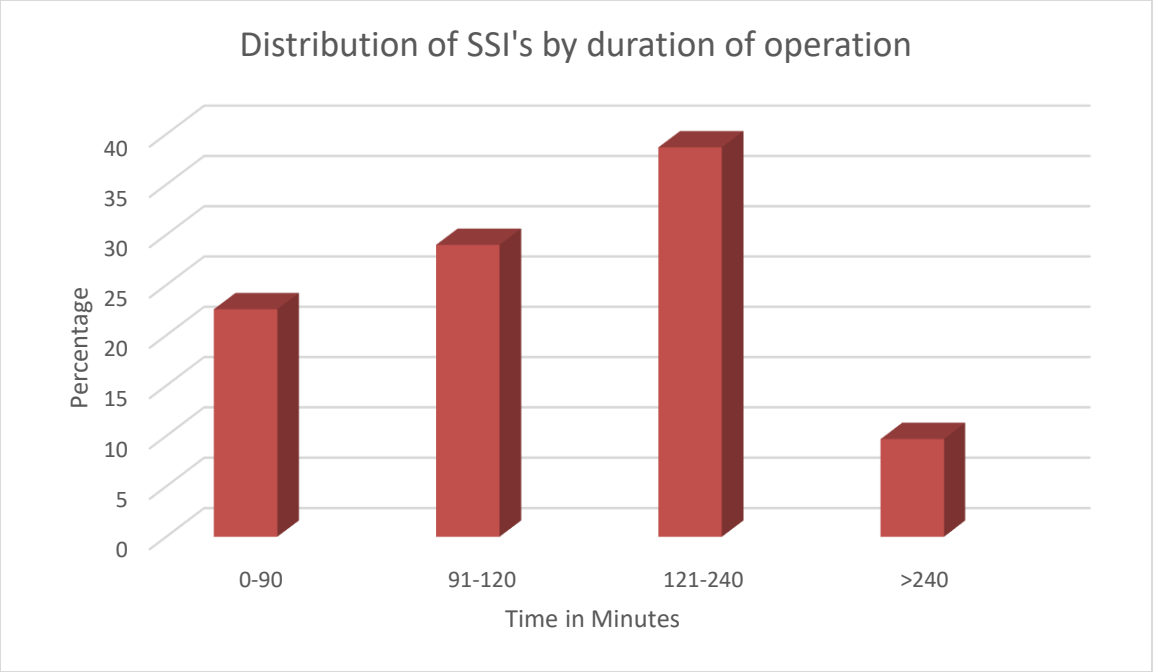


Figure 5: Distribution of SSI by duration of operation

4.6. Antibiotic Use

Table 7: Antibiotic Use

The antibiotic use of the patients is as shown by the table below.

Drug dosage	**Before surgery**		**After surgery**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Before surgery				
Multiple doses	39	62.9%	62	100%
Single dose	23	37.1%	0	0%
Total	62	100%	62	100%

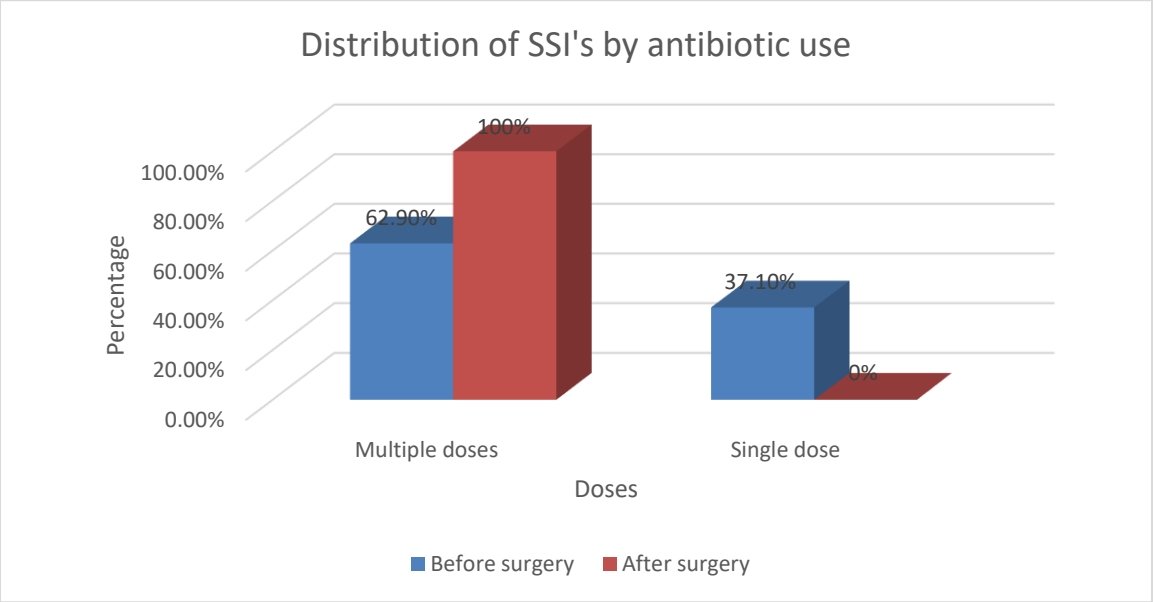


Figure 6: Distribution of SSI by antibiotic use

4.7. Date of Detection of SSI

Table 8: Date of Detection of SSI

The date of detection of SSI of the patients is as shown by the table below.

	Frequency	Percentage
0-4 day	32	51.6
5-7 day	26	41.9
After 7th day	4	6.5
Total	62	100%

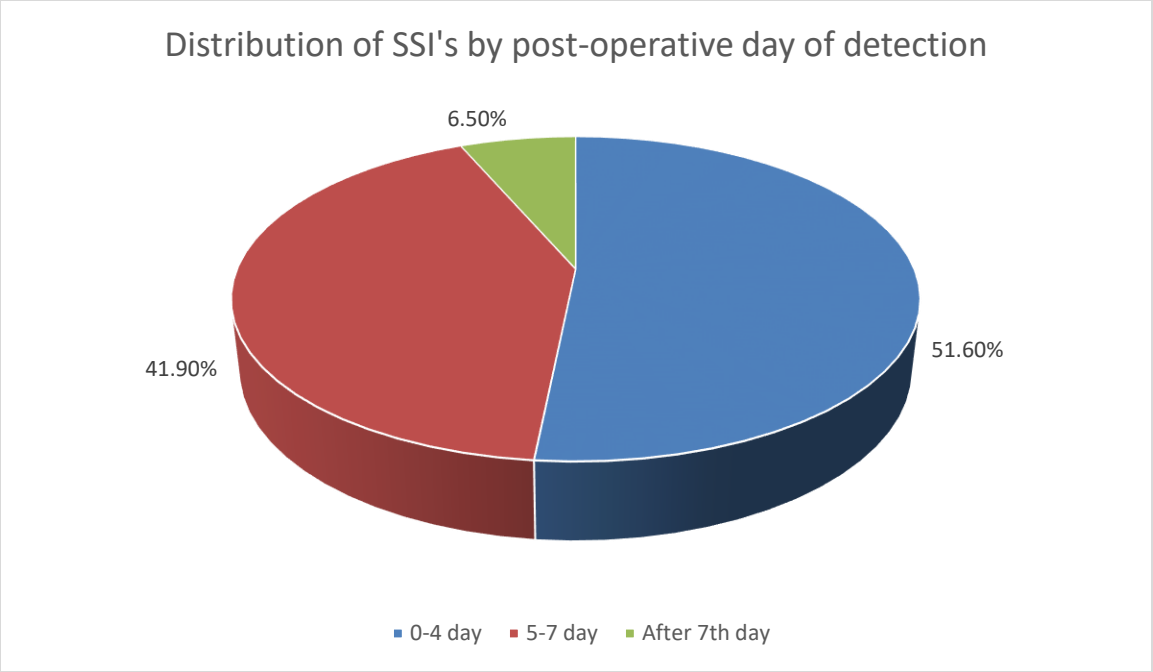


Figure7: Distribution of SSI by date of detection post-operatively

4.8. Type of SSI

Table 9: Type of SSI

The type of SSI of the patients is as shown by the table below.

Type of SSI	Frequency	Percentage
Deep	24	38.7
Organ space	11	17.7
Superficial	27	43.5
Total	62	100%

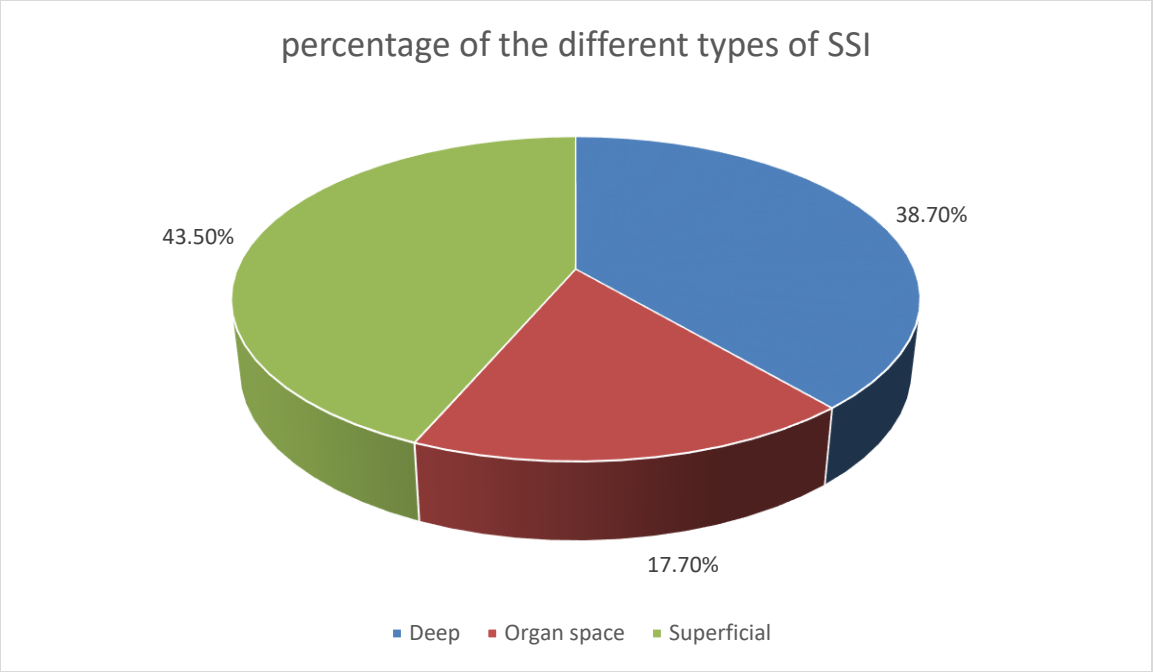


Figure 8: Distribution of types of SSI

4.9. Prevalence of Bacterial Isolates

This section presents the results of the prevalent bacterial isolates in SSI wounds in general surgical wards in KNH.

4.9.1. Growth of microorganisms

Table 10: Growth Vs No growth

	Frequency	Percentage
Growth	54	88.1%
No growth	8	11.9%
Total	62	100%

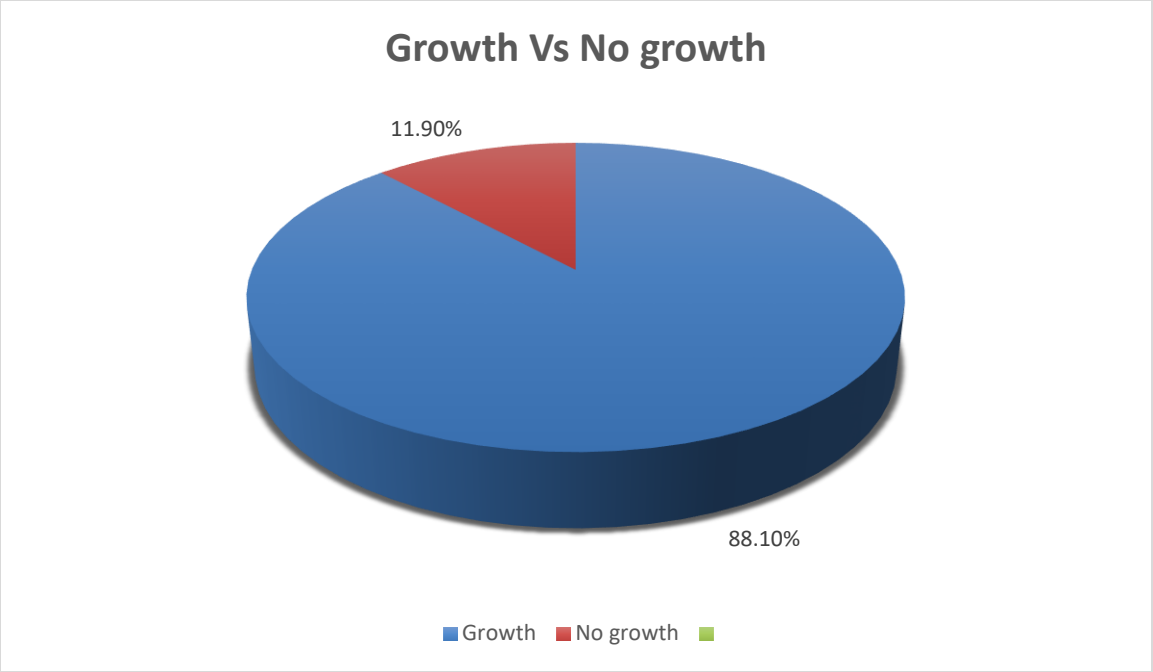


Figure 9: Growth Vs No growth

Growth of micro-organisms occurred in 88.10% of SSI specimens with no growth in 11.90%. The no growth specimens could be attributed to antibiotic use. This means some patient are receiving antibiotics they don't need.

4.9.2. Organisms grown

Table 11: Organisms grown

The type of organism is as shown by the table below.

Organism	Frequency	Percentage
Acinetobacter baumabii	5	9.3
Citrobacter freundii	1	1.9
Coagulase negative Staph	2	3.7
E. coli	21	38.9
Enterobacter cloacae	1	1.9
Enterococcus faecalis	2	3.7
Klebsiela pneumoniae	5	9.3
Klebsiela ssp	3	5.6
Morganella morganii	1	1.9
Proteus mirabilis	1	1.9
Pseudomonas auregenosa	4	7.4

Serratia liquefaciens	2	3.7
Staphylococcus aureus	4	7.4
Staph epidermis	2	3.7

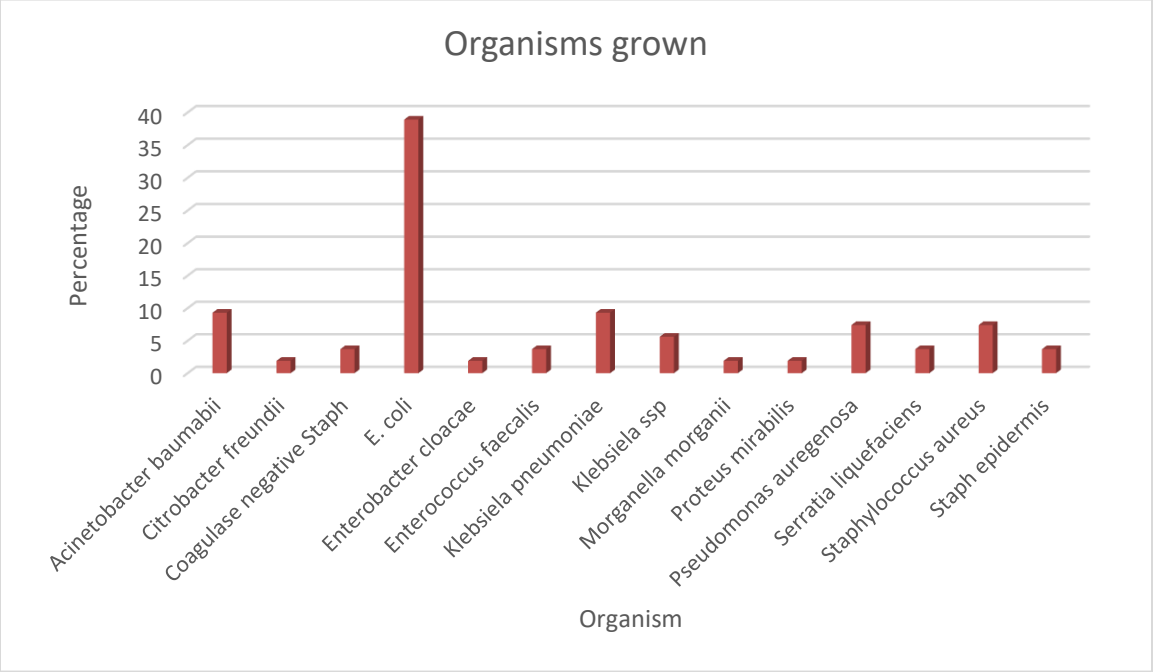


Figure 10: Distribution of microorganism grown

4.9.3. Antimicrobial Sensitivity in Bacterial Isolates

This section presents the results of the antimicrobial sensitivity in bacterial isolates in SSI wounds in general surgical wards in KNH.

The results of the antimicrobial sensitivity is as shown by the table below.

4.9.3.1. Klebsiella sensitivity profile

Table 12: Klebsiella Pneumoniae

Drug	S	**R**
Ampicillin	9%	100%

Amoxicillin/Clavulanic acid	60%	20%
Ampicilin/Sulbactam	40%	60%
Piperacillin/Tazobactam	60%	20%
Cefazolin	40%	60%
Cefuroxime	40%	60%
Cefotaxime	40%	60%
Ceftazidime	40%	60%
Ceftriaxone	40%	60%
Cefepime	60%	40%
Aztrenam	40%	60%
Meropenem	100%	0%
Amikacin	80%	20%
Gentamicin	80%	20%
Ciprofloxacin	60%	40%
Trimethoprim/Sulfamethoxazole	67%	33%

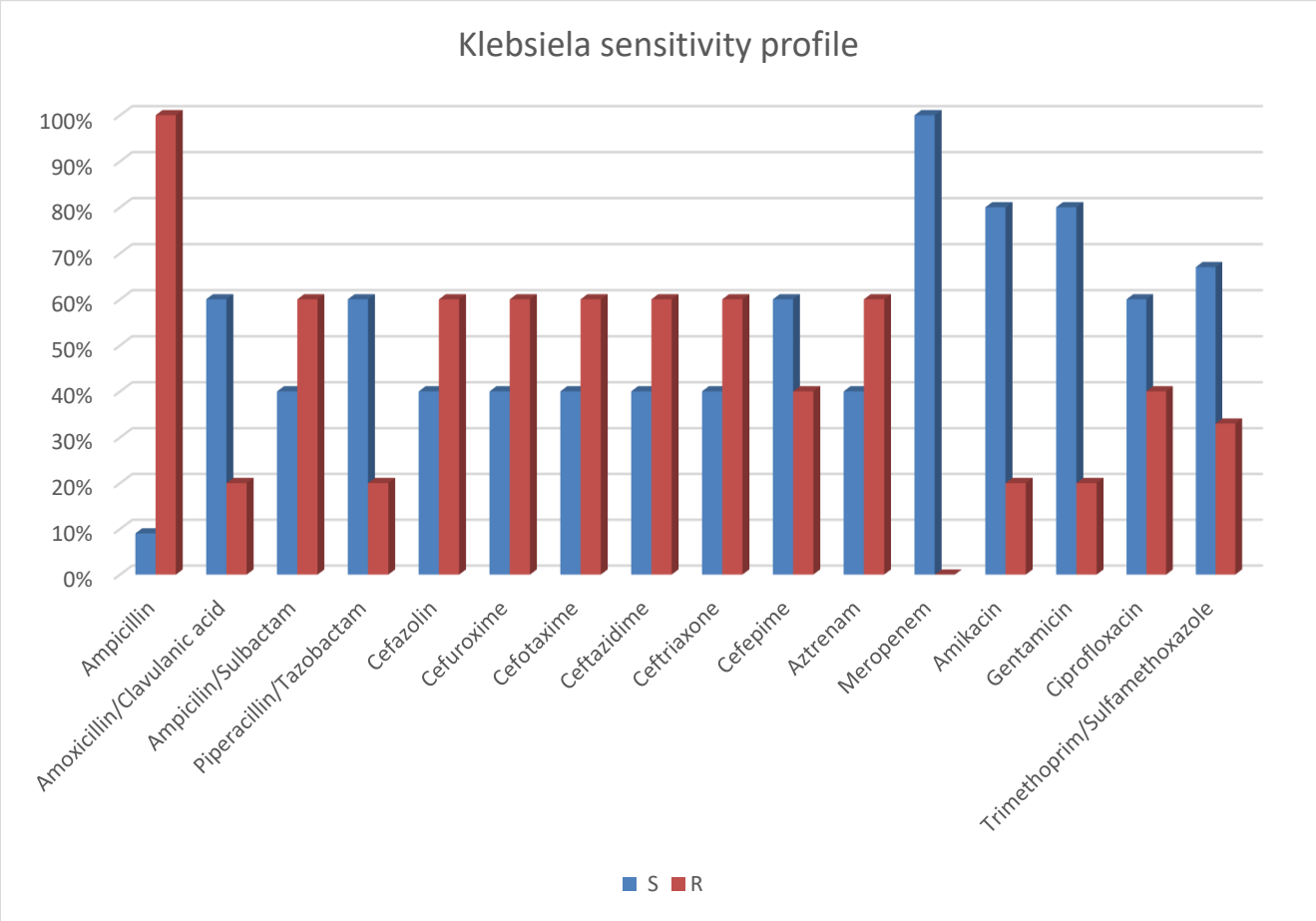
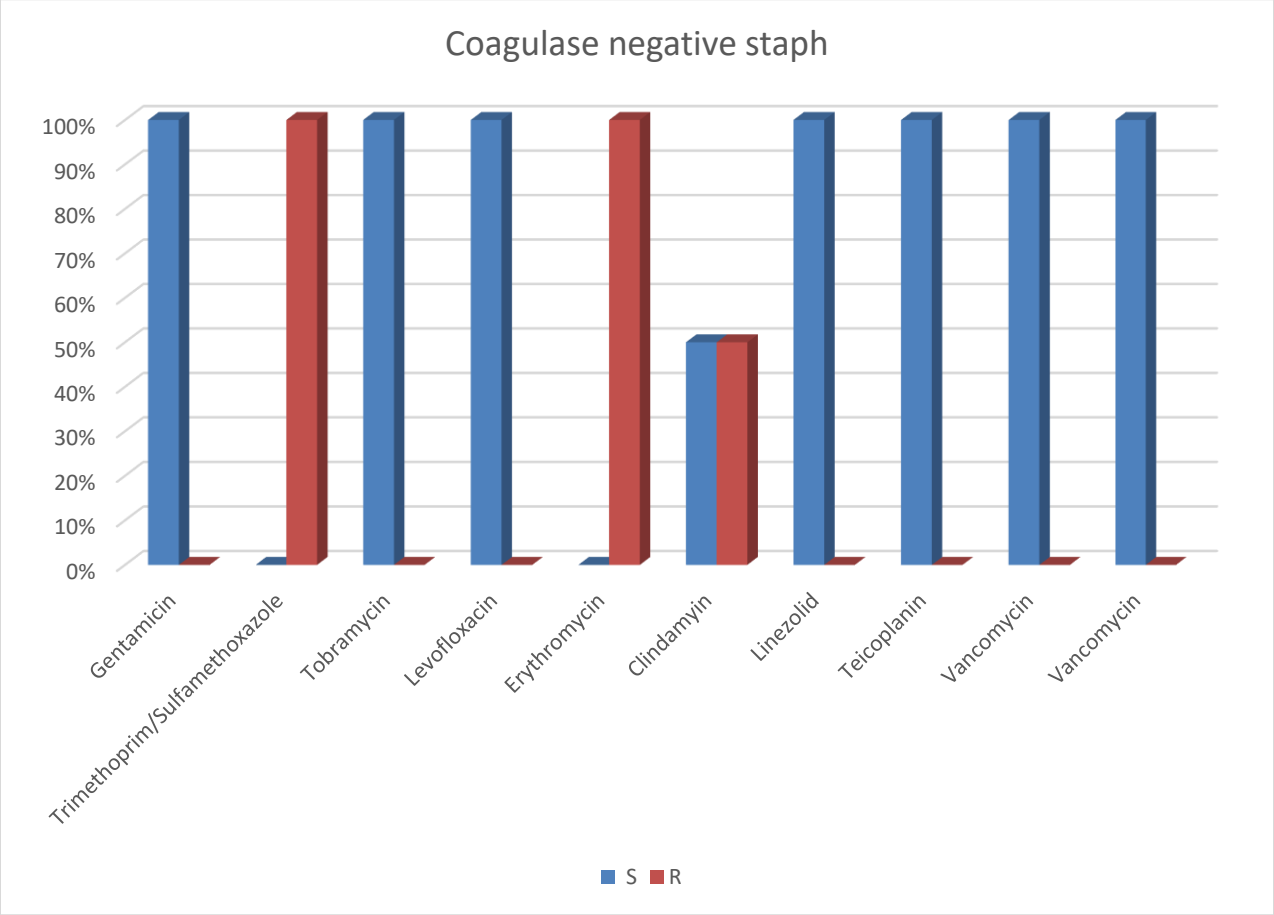


Figure 11: Klebsiella sensitivity profile

4.9.3.2. Sensitivity profile of Coagulase negative staphylococcus

Table 13: Coagulase Negative Staphylococcus

Drug	S	R
Gentamicin	100%	0%
Trimethoprim/Sulfamethoxazole	0%	100%
Tobramycin	100%	0%
Levofloxacin	100%	0%
Erythromycin	0%	100%
Clindamyin	50%	50%
Linezolid	100%	0%
Teicoplanin	100%	0%
Vancomycin	100%	0%



4.9.3.3. Sensitivity profile of E. coli

Table 14: E. coli

Drug	S	R
Ampicillin	0%	100%
Amoxicillin/Clavulanic acid	14%	43%
Ampicilin/Sulbactam	7%	93%
Piperacillin/Tazobactam	57%	33%
Cefazolin	6%	88%
Cefuroxime	14%	86%
Cefotaxime	29%	71%
Ceftazidime	29%	71%
Ceftriaxone	24%	76%
Cefepime	24%	76%
Aztrenam	21%	79%
Meropenem	86%	14%
Amikacin	90%	5%
Gentamicin	81%	19%
Ciprofloxacin	48%	52%

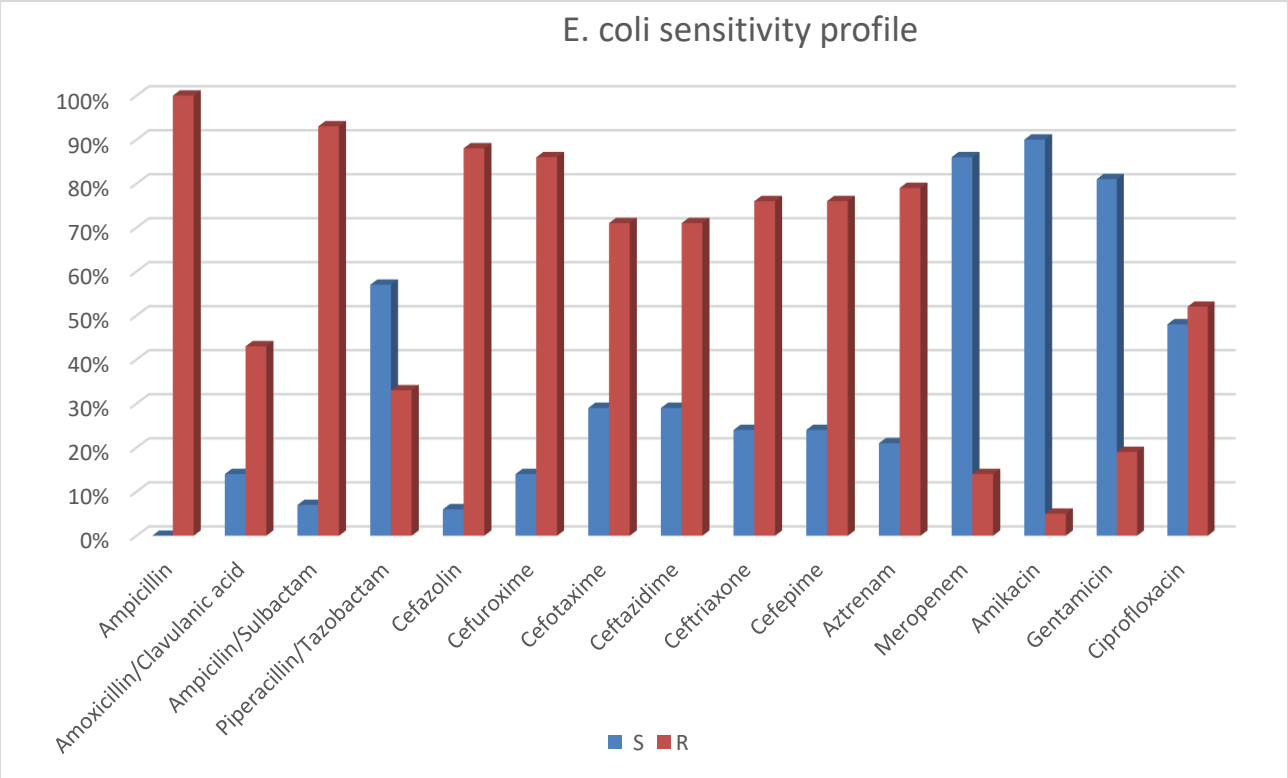


Figure 13: Sensitivity profile of E. coli

4.9.3.4. Sensitivity profile of Enterococcus faecalis

Table 15: Enterococcus faecalis

Drug	S	R
Ampicillin	0%	100%
Gentamicin	100%	0%
Tobramycin	0%	100%
Levofloxacin	0%	100%
Erythromycin	0%	100%
Linezolid	100%	0%
Teicoplanin	100%	0%
Tigecycline	100%	0%
Vancomycin	100%	0%

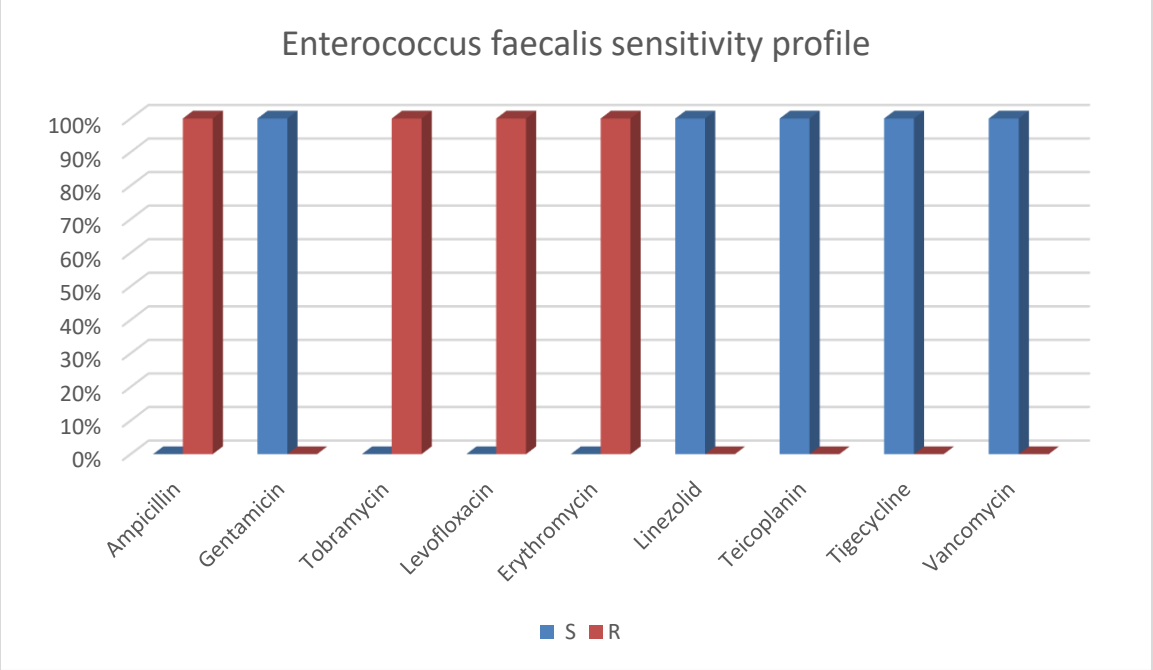


Figure 14: Sensitivity profile of Enterococcus faecalis

4.9.3.5. Klebsiella ssp sensitivity profile

Table 16: Klebsiella ssp

Drug	S	R
Ampicillin	0%	100%
Amoxicillin/Clavulanic acid	67%	33%
Ampicilin/Sulbactam	0%	100%
Piperacillin/Tazobactam	67%	33%

Cefazolin	0%	100%
Cefuroxime	0%	100%
Cefotaxime	0%	100%
Ceftazidime	0%	100%
Ceftriaxone	0%	100%
Cefepime	67%	33%
Aztrenam	0%	100%
Meropenem	67%	33%
Amikacin	100%	0%
Gentamicin	R	100%
Ciprofloxacin	67%	33%
Trimethoprim/Sulfamethoxazole	0%	100%
Levofloxacin	100%	0%

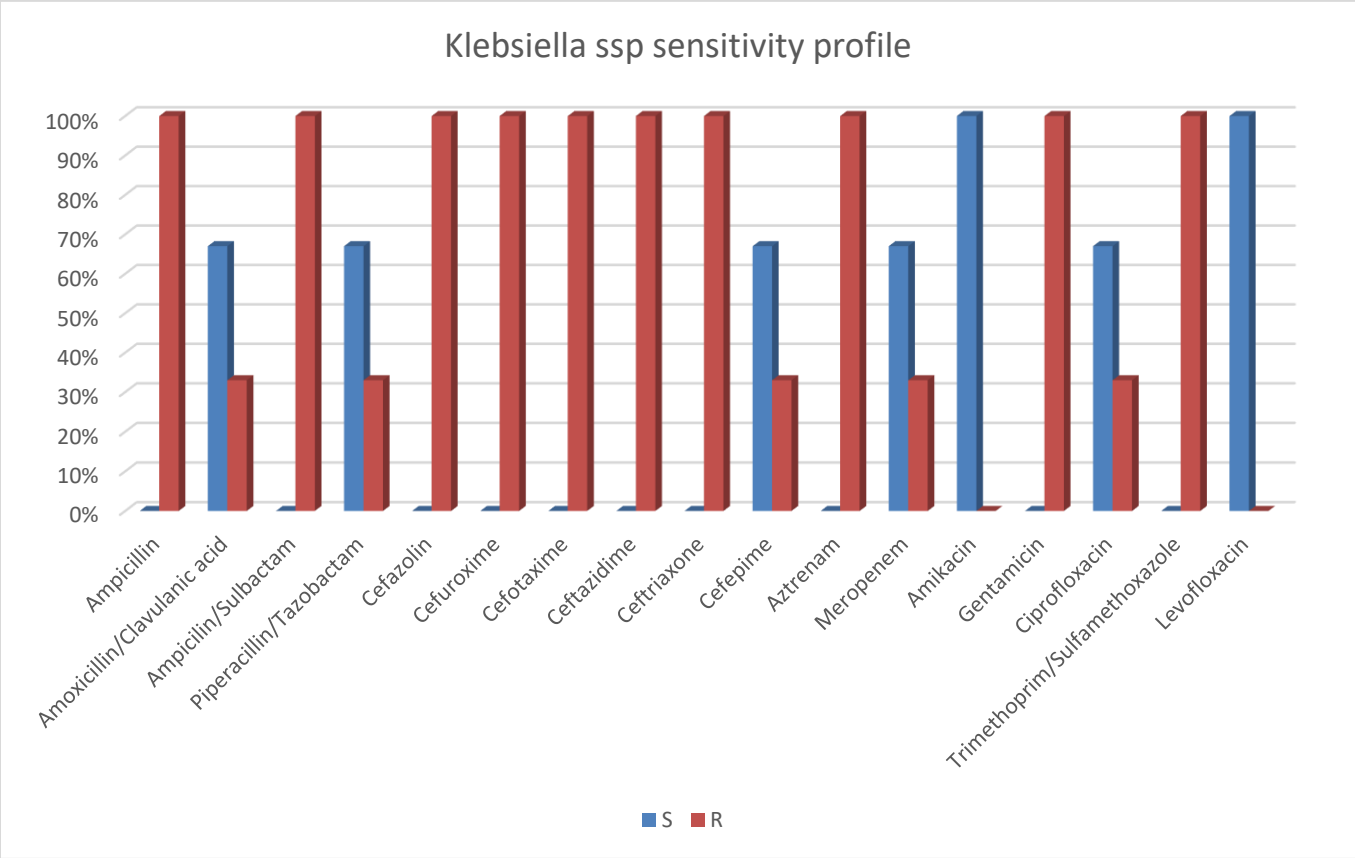


Figure 15: Klebsiella ssp sensitivity profile

4.9.3.6. Proteus mirabilis sensitivity profile

Table 17: Proteus mirabilis

Drug	S	R
Ampicillin	0%	100%
Amoxicillin/Clavulanic acid	0%	100%
Ampicilin/Sulbactam	0%	100%
Piperacillin/Tazobactam	0%	100%
Cefazolin	0%	100%
Cefuroxime	0%	100%
Cefotaxime	0%	100%
Ceftazidime	0%	100%
Ceftriaxone	0%	100%
Cefepime	0%	100%
Aztrenam	0%	100%
Meropenem	100%	0%
Amikacin	100%	0%
Gentamicin	0%	100%
Ciprofloxacin	0%	100%
Trimethoprim/Sulfamethoxazole	0%	100%

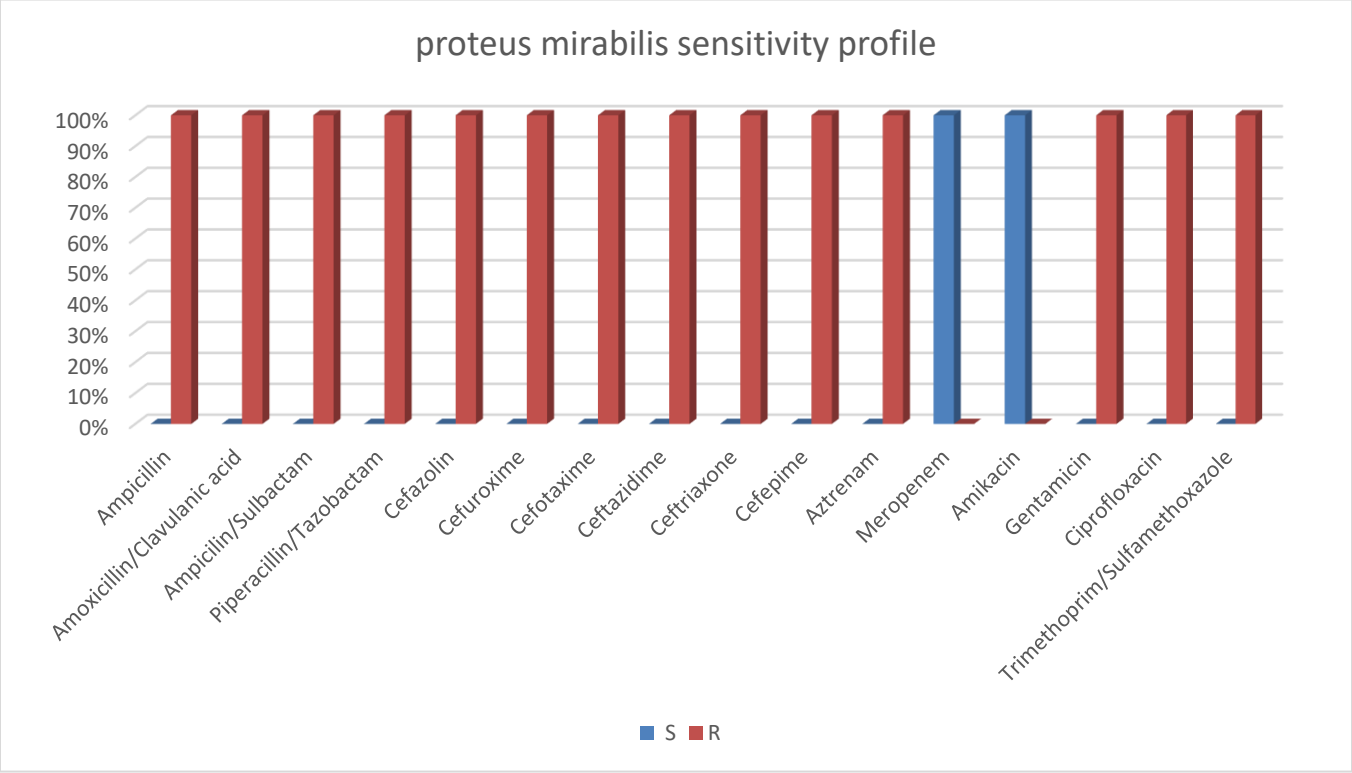


Figure 16: Proteus mirabilis sensitivity profile

4.9.3.7. Pseudomonas aeruginosa sensitivity profile

Table 18: Pseudomonas aeruginosa

	S	R
Piperacillin/Tazobactam	100%	0%
Cefazolin	0%	50%
Cefotaxime	0%	100%
Ceftazidime	75%	25%
Cefepime	75%	25%
Meropenem	100%	0%
Amikacin	100%	0%
Gentamicin	75%	0%
Ciprofloxacin	100%	0%

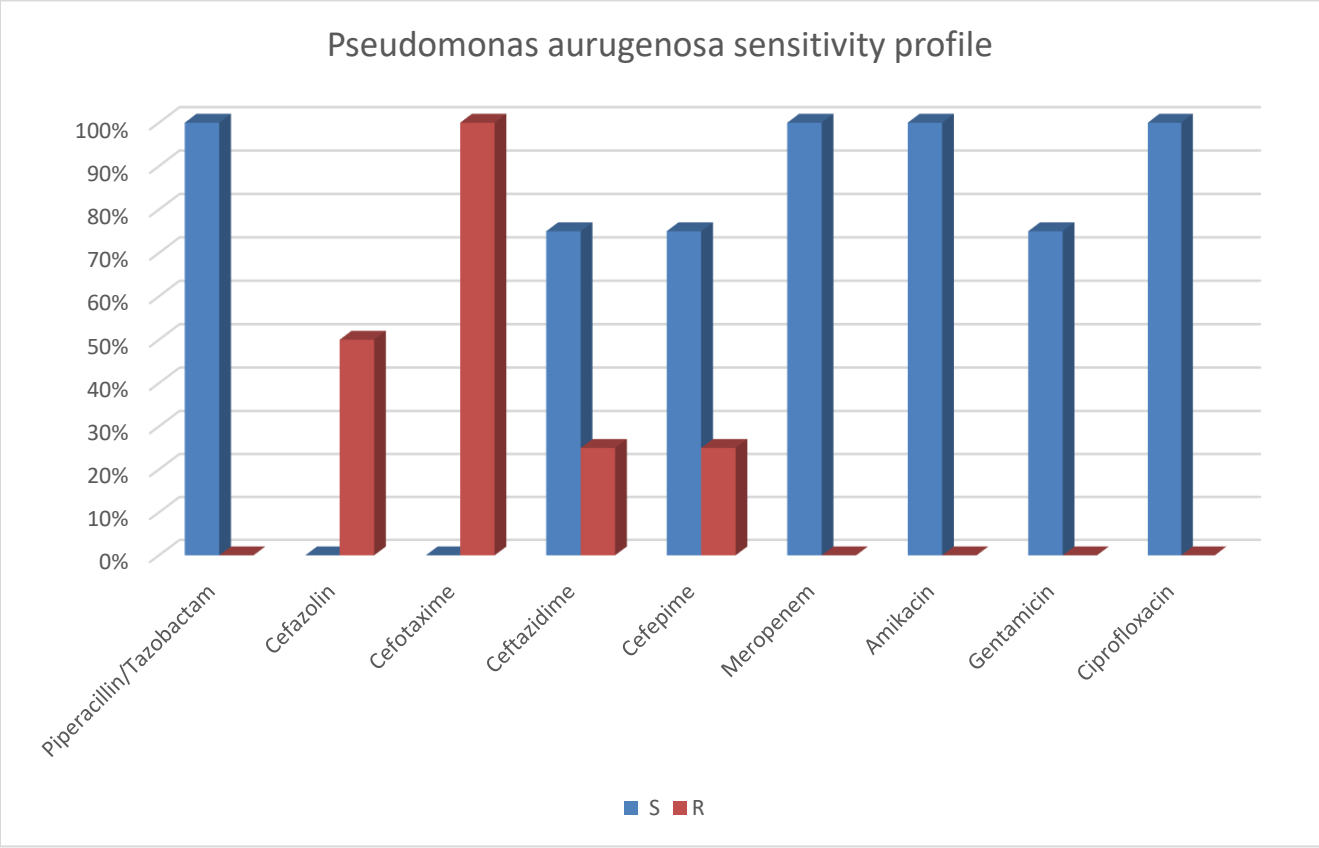


Figure 17: Pseudomonas aeruginosa sensitivity profile

4.9.3.8. Staphylococcus aureus sensitivity profile.

Table 19: Staphylococcus aureus

Drug	S	R
Benzyl Penicillin	0%	100%
Gentamicin	80%	20%
Tobramycin	80%	20%
Levofloxacin	80%	0%
Moxifloxacin	80%	0%
Erythromycin	60%	40%
Clindamyin	80%	20%
Linezolid	100%	0%
Teicoplanin	100%	0%
Tigecycline	100%	0%
Vancomycin	100%	0%

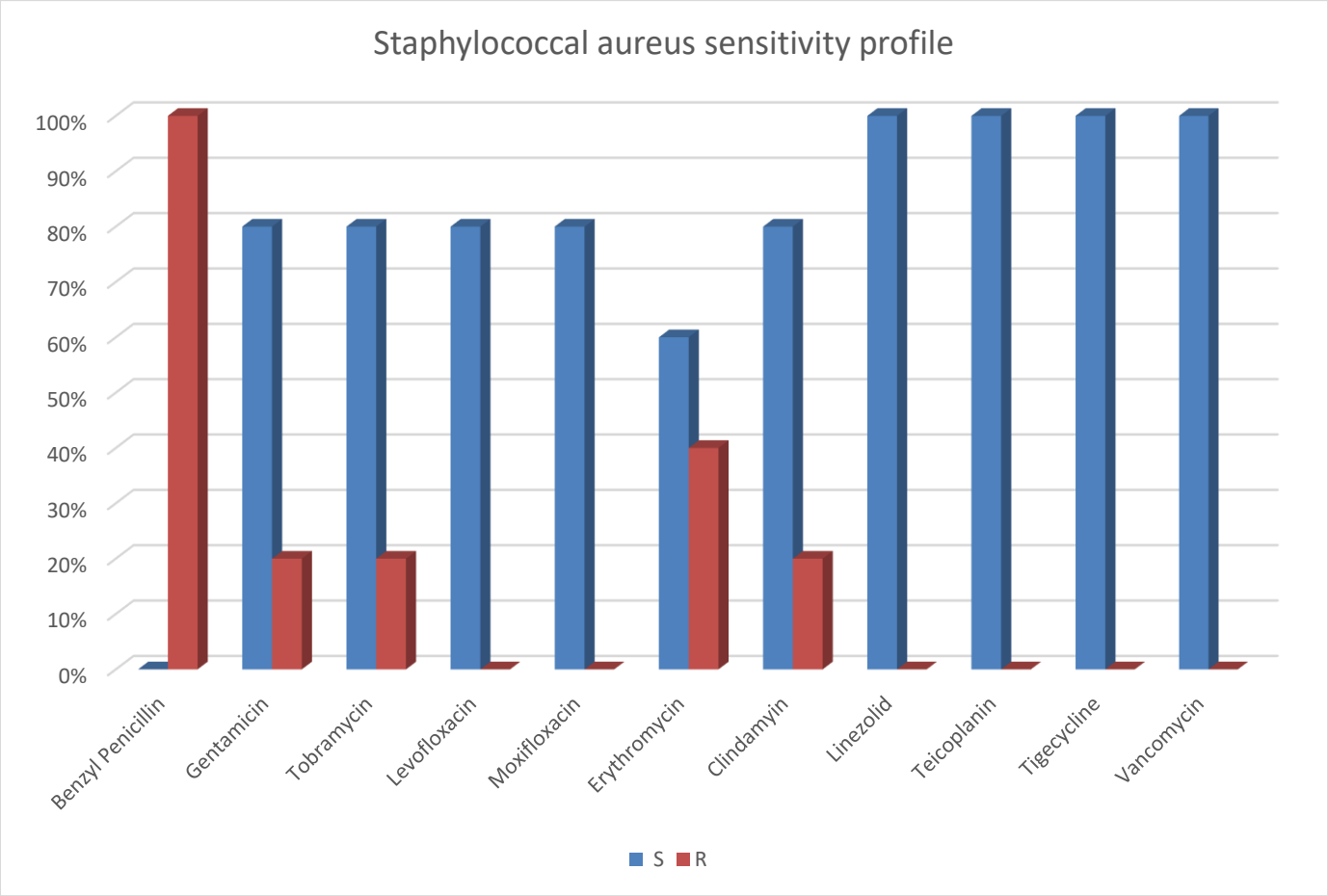


Figure 18: Staphylococcus aureus sensitivity profile.

4.90. Association in E. coli between the different type of operation and drug sensitivity

Table 20: Association between the various categories of operations and E. coli sensitivity to different types of antibiotics

	R	S	Total	p-value
Ceftazidime				
GIT	7 (46.7)	2 (40.0)	9 (45.0)	1.000
Non GIT	8 (53.3)	3 (60.0)	11 (55.0)	
Ceftriaxone				
GIT	8 (50.0)	2 (40.0)	10 (47.6)	1.000
Non GIT	8 (50.0)	3 (60.0)	11 (52.4)	
Meropenem				
GIT	1 (33.3)	9 (52.9)	10 (50.0)	1.000
Non GIT	2 (66.7)	8 (47.1)	10 (50.0)	
Ciprofloxacin				
GIT	5 (45.5)	4 (44.4)	9 (45.0)	1.000
Non GIT	6 (54.5)	5 (55.6)	11 (55.0)	

5.0 DISCUSSION

The gender distribution of SSIs is 64.5% male and 35.5% for women. This is in tandem with a study done by Miima et al (2016)[8] in KNH that showed 67.6% for males and 32.4% for females. A study by Bastula et al (2017) showed 71% males verses 29% females which was similar to our study and previously done studies.

From the study, 64.4% of SSIs occurred within the age bracket of 18-35 years of age. This is the most economically active age bracket. This study gave similar results as a previous local study by Miima et al (2016)[8] that the mean age for most SSIs was 35.5 years. An international study by Satyanarayan et al showed a similar result. [27]

The most common diagnosis among the SSI patients was peritonitis without bowel injury at 17.7% followed closely by appendicitis at 16.1% while GIT disease was at 27.3% with colonic perforation leading at 4.8%. Biliary and urological diseases were at 4.8% each. From the study, most of the operations were done on emergency setting (77.4%). Only 22.6% were elective. This shows that emergency operations are prone to contamination compared to elective ones.

The study shows that most (77.4%) of the patients who developed SSIs had the operation lasting more than 90 minutes. A previous study in the same setting showed the mean duration of operation associated with SSI as 155 minutes.[8] Bacterial contamination increases with the duration of surgery, also the cells are increasingly damaged by exposure to air or to trauma due to surgical instruments or because longer procedures are more liable to be associated with blood loss and shock thereby reducing the patients general resistant. All these factors may contribute to increased rate of infection with increase in duration of surgery.

In this study, all the patients who developed SSI had antibiotic before surgery. Of these, 62.9% had multiple doses while 37.1% had single dose antibiotics. All the patients had multiple doses of antibiotics post operatively. This shows that prolonged antibiotic therapy is not associated with reduced risk of SSI. This is supported by a study done by Stephen Harbarth et al that showed prolonged antibiotic prophylaxis had no relation with reduced risk of SSIs and was associated with increase in risk of antibiotic resistance. **(5)** A study by Mwendwa K M[7] done at KNH found that patients treated with antibiotics for more than 5 days had an SSI prevalence of 29.2% compared to those on shorter time of antibiotic therapy at 7.5%.

The study showed that over 50% (51.6%) of SSIs were detected within the first four (4) post-operative days. This number rose to 93.5% by the seventh (7^{th}) post-operative day. The most common type of SSI was superficial at 43.5% followed closely by deep SSI at 38.7%. This contradicts a study done at the same site that showed organ space SSI was the most prevalent though the study was on emergency abdominal operations only.

The mostly cultured organism is E. coli at 38.9% this is followed at a distant by klebsiella pneumonia and Acinetobacter baumabii at 9.3% each. This finding was consistent with two earlier local studies that showed that E. coli was the most prevalent microorganism in SSI's at 48.6% [7,8].However most of the non-local studies showed staphylococcal aureus as the most prevalent microorganism[13,16]. Mono-microbial SSI accounted for 93.5 % while poly-microbial represented 6.5% of SSIs.

Klebsiella pneumoniae had over 90% resistance to penicillin. There is poor response to cephalosporin. There was variable response to aminoglycosides and quinolones. The only drug with over 90% sensitivity was meropenem. Coagulase negative staphylococcus had excellent sensitivity to most antibiotic except trimethoprim/sulfamethoxazole and erythromycin which had

100% resistance. These drugs are however hardly used in KNH surgical wards. E. coli is the most important microorganism in SSI since it accounts for almost half of the SSI infective microorganisms. There is 100% resistance to penicillin and also high resistance (over 80%) to cephalosporin. There is also more than 50% resistance to cephalosporin. This is in tandem with the Infectious Diseases Society of America guidelines on treatment of E. coli infection in which ampicillin-sulbactam is not recommended because of high rates of resistance to this agent among E. coli, and quinolones should not be used unless surveys indicate over 90 % susceptibility of E. coli. In this study, resistant E. coli strains were 92 % to ampicillin-sulbactam and 48 % to ciprofloxacin. These antibiotics seem not to be recommended for the treatment of postoperative intraabdominal infections. E. coli is sensitive (over 90%) to carbenems and aminoglycosides including gentamicin.

E. coli being the most common microorganism grown, the operations were divided into GIT and non-GIT. The association between E.coli from these two (2) groups and their sensitivity for the commonly used antibiotics i.e. ceftriaxone, ceftazidime, meropenem and ciprofloxacin was done. In ceftriaxone, the sensitivity of the GIT and non-GIT was 46.7% resistance for GIT versus 53.3% for non-GIT while the sensitivity was 40% versus 60% respectively. From the study the association between the anatomical operation and the sensitivity to ceftriaxone was statistically insignificant (p-value 1.00). The same was observed with the rest of the drugs whose association was done.

Conclusion

Doing culture and sensitivity on all patients with surgical site infection helps to have a focused and targeted cover of the causative organism. This helps minimize the length of hospital stay and consequently the cost of treatment. Knowledge of the common causative microorganisms and the antimicrobial sensitivity pattern becomes helpful when empirical treatment has to be initiated before culture results.

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Appendix I:

Consent form

ANTIMICROBIAL SUSCEPTIBILITY IN SURGICAL SITE INFECTIONS IN GENERAL SURGICAL WARDS AT KENYATTA NATIONAL HOSPITAL KENYA

RESEARCHER: Dr. Robert Maweu Mutula, a post graduate student at the University of Nairobi's School of Medicine undertaking a Masters degree in general surgery.

Purpose for the Study: The purpose of this study is to establish the causative organisms for wound infections and their antibiotic susceptibility.

Procedure

The study will include specimen collection of pus from your wound. This will be done during normal wound dressing but for this specific one a nurse assisting in the study will be the one to do thorough cleaning of the wound. After cleaning we will take a specimen from the wound using a sterile swab stick that will be taken to the laboratory to check for bacterial growth and the response of the bacteria to different antibiotics. You will have a right to demand for analgesic if the procedure is painful. I also request for your permission to access you file personal details and the kind of operation done as well as antibiotics given.

Confidentiality: The information obtained from your file will be treated with confidentiality and only be available to the principal investigator and the study team. Your name will not be

indicated in the checklist used to collect information from your file. The information will also be available to the healthcare workers within KHN and UON as well as other policy makers.

Benefits and Risks: You will not be adversely affected or harmed in any way by deciding to participate in the study. You will not pay any extra amount of money in the final bill for participating in this study and neither will there be given any reward for participating. You can choose to participate in the study or not. If you choose not to participate then you will continue to receive the treatment you are currently receiving and there will be no change in your treatment.

This proposal has been reviewed by the University of Nairobi School of Medicine Department of Surgery and approved by the KNH/UoN Ethics and Research Review Committee. This Committee makes sure that research participants are protected from harm in the course of research. If you wish to ask any questions later, you may contact:

Principal researcher:

Dr. Robert Mutula

Department of Surgery, School of Medicine, University of Nairobi

P.O. Box 19676 KNH, Nairobi 00202

Mobile Number: 0721327750

University of Nairobi Supervisors:

Dr Julius Kiboi

MBChB (UoN), MMed General Surgery (UoN)

SeniorLecturer

Department of Surgery

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Dr. Mark Nelson Awori

MBChB (UoN), MMed General Surgery (UoN)

Senior Lecturer

Department of Surgery

University of Nairobi

Kenyatta National Hospital Supervisor;

Dr Eric Hungu

Consultant General Surgeon

Kenyatta National Hospital

If you have any ethical concerns, you may contact:

Secretary, KNH/UoN-ERC

P.O. Box 20723 KNH, Nairobi 00202

Tel +254-020-2726300-9 Ext 44355

Email: KNHplan@Ken.Healthnet.org

Statement by the study participant/Guardian

I do hereby confirm that I have read the above consent form and the researcher gave me the chance to ask questions about any concerns that I might have had as far as the study is concern. I

herein give my full authorization to the researcher to carry out the study and I've been assured of confidentiality, safety and that no costs shall accrue to me arising from the study.

Signature/ Thumb print of participant

Of Participant/Guardian _____

Date _____

Statement by the researcher/research assistant

The information about this study has been read to and interpreted to the participant and that adequate time was given to the participant to air any concerns was given. Assurance was given that:-

1. Utmost confidentiality will be observed on all information gathered.
2. The results of this study might be published to facilitate planning for and management of patients that have had SSIs.

   I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Name of researcher /research assistant taking consent _____

Signature of researcher/research assistant taking consent _____

Date _____

Fomu ya Idhini

Mada kuu la utafitini **"**ANTIMICROBIAL SUSCEPTIBILITY IN SURGICAL SITE INFECTIONS IN GENERAL SURGICAL WARDS AT KENYATTA NATIONAL HOSPITAL KENYA**"**

Mtafiti mkuu: Dr Robert Maweu Mutula, nasomea uzamili katika idara ya upasuaji chuo kikuu cha Nairobi.

Nia ya Utafiti: "kujua vijidudu vinavyosababisha epetevu wa vidonda vya upasuaji na dawa ambazo zinaeza kusaidia".

Habari zitakazotokana na utafiti huu zitawekwa siri, na zitajulikana tu na mtafiti pamoja na wasaidizi wake. Jina lako halitatumiwa kutoa taarifa zozote.Habari zozote kukuhusu zitatambulika kwa kodi ya nambari badala ya jina. Matokeo ya utafiti huu yatatangazwa kwa Wizara ya Afya na madaktari kupitia chapa na kongamano za kisayansi. Habari za siri hazitatangazwa.Utafiti huu utatekelezwa kupitia upekuzi wa faili yako. Kuchagua kuhusika katika utafiti huu hautakudhuru kwa njia yeyote. Hakuna gharama yoyote ya kuhusika katika utafiti huu.Vilevile, hakuna malipo yeyote.Utafiti huu umeidhinishwa na idara ya upasuaji katika Chuo Kikuu cha Nairobi, pamoja na kamati ya maswala ya utafiti KNH/UoN. Idara na kamati hii zina hakikisha kuwa utafiti hauna madhara yoyote kwa wahusika.

Ikiwa ungependa kuuliza maswali yeyote baadaye,tafadhali wasiliana na:

Mtafiti mkuu:

Dr Robert Maweu Mutula

Department of Surgery, School of Medicine, University of Nairobi,

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Nimesoma ama nikasomewa maelezo ya awali, nikapata nafasi ya kuuliza maswali yoyote, na nikajibiwa kwa ukamilifu. Nakubali sasa,kwa hiari yangu mwenyewe kuhusikana katika utafiti huu.

Sahihi ya mhusika_____

Tarehe _____

Ikiwa mhusika hana sahihi:

Kidole gumba cha mhusika_____

Tarehe _____

Taarifa Kutoka Kwa Mtafiti

Nimemsomea mhusika mukhtasari wa utafiti na nikajizatiti kuhakikisha kuwa anaelewa ya kwamba yafuatayo yatatendeka:

a) Ujumbe wowote utakaopatikana utatendewa usiri.

b) Matokeo ya utafiti huu yanaweza yakachapishwa ili kusaidia katika haja

Mhusika amepata nafasi ya kuuliza maswali kuhusu utafiti, na maswali yake yote yamejibiwa kwa ukamilifu jinsi niwezavyo. Mhusika hajalazimishwa kutoa ruhusa kuhusika katika utafiti huu,na ametoa ruhusa kwa hiari yake mwenyewe.

Jina la mtafiti/ msaidizi wa mtafiti_____

Sahihi ya mtafiti/msaidizi wa mtafiti_____

Tarehe_____

Minor Assent form

Study Title: ANTIMICROBIAL SUSCEPTIBILITY IN SURGICAL SITE INFECTIONS IN GENERAL SURGICAL WARDS AT KENYATTA NATIONAL HOSPITAL KENYA

Investigator: Dr Robert Mutula

I am doing a study on the different types of bacteria in infected wound after surgery. This study will involve collecting pus from the wound and taking it to the Kenyatta hospital laboratory for examination. The study will also look at how the microorganisms respond to different antibiotics.

Note that this will not in any way harm you or make you incur extra costs in your treatment.

If you do not want to participate in the study, which decision will not affect your treatment in any way and you will be treated with a broad spectrum antibiotics that will cover your infection so you will not be disadvantaged in any way.

Purpose for the Study: The purpose of this study is to establish the causative organisms for wound infections and their antibiotic susceptibility.

Procedure

The study will include specimen collection of pus from your wound. This will be done during normal wound dressing but for this specific one a nurse assisting in the study will be the one to do thorough cleaning of the wound. After cleaning we will take a specimen from the wound using a sterile swab stick that will be taken to the laboratory to check for bacterial growth and the response of the bacteria to different antibiotics. You will have a right to demand for analgesic if the procedure is painful. I also request for your permission to access you file personal details and the kind of operation done as well as antibiotics given.

Confidentiality: The information obtained from your file will be treated with confidentiality and only be available to the principal investigator and the study team. Your name will not be indicated in the checklist used to collect information from your file. The information will also be available to the healthcare workers within KHN and UON as well as other policy makers.

Benefits and Risks: You will not be adversely affected or harmed in any way by deciding to participate in the study. You will not pay any extra amount of money in the final bill for participating in this study and neither will there be given any reward for participating. You can choose to participate in the study or not. If you choose not to participate then you will continue to receive the treatment you are currently receiving and there will be no change in your treatment.

This proposal has been reviewed by the University of Nairobi School of Medicine Department of Surgery and approved by the KNH/UoN Ethics and Research Review Committee. This Committee makes sure that research participants are protected from harm in the course of research.

When we are finished with this study we will write a report about what was learned. This report will not include your name or that you were in the study.

Your parents know about the study and have agreed for you to participate.

If you decide you want to be in this study, please sign your name.

I ……would like to participate in the study.

Signature…….Date…….

Appendix II: Data Sheet
ANTIMICROBIAL SUSCEPTIBILITY IN SURGICAL SITE INFECTIONS AFTER ABDOMINAL SURGERY IN KENYATTA NATIONAL HOSPITAL KENYA

Checklist number: _____

Section A. Demographic Data

1. Age in years_____
2. Gender
   a) Male []
   b) Female []

Section B: Date of admission_____

Section C: Diagnosis at admission_____

Section D: Social history

a) Alcohol use Yes No
b) Cigarettes use Yes No

Section E: Co-morbid/Immunosuppressive conditions

a) HIV/AIDS
b) Prior radiation
c) Diabetes
d) Prolonged steroid use
e) Cancer

Section F: Operation

Date of operation_____

Type Emergency

Elective

Duration of operation_____

Section G: Antibiotic given before surgery

i) Prophylaxis

a) Single dose

b) Multiple doses

ii) Treatment

a) Single dose

b) Multiple doses

Section H: Antibiotic after surgery

i) Prophylaxis

a) Single dose

b) Multiple doses

ii) Treatment

a) Single dose

b) Multiple doses

Yes No

Section I: Date of SSI detection_____

Section J: Type of SSI

a) Superficial
b) Deep
c) Organ space

Section K: Specimen taken for culture and sensitivity

a) Date taken_____

b) Date results back_____

c) Report

List of bacteria isolated…

Table of the sensitivity of each microbe and the corresponding drugs with the sensitivity levels

Bacteria Isolate					
Code	Antibiotic	MIC	%Susceptible	%Intermediate	% Resistant
Bacteria Isolate					
Code	Antibiotic	MIC	%Susceptible	%Intermediate	% Resistant